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(54) **BRUSH CLEANING SYSTEM**

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(51) **Int. Cl.**

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A46B 17/06	(2006.01)
B08B 1/00	(2006.01)
A46B 15/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A46B 17/06*** (2013.01); ***B08B 1/007*** (2013.01); *A46B 15/0018* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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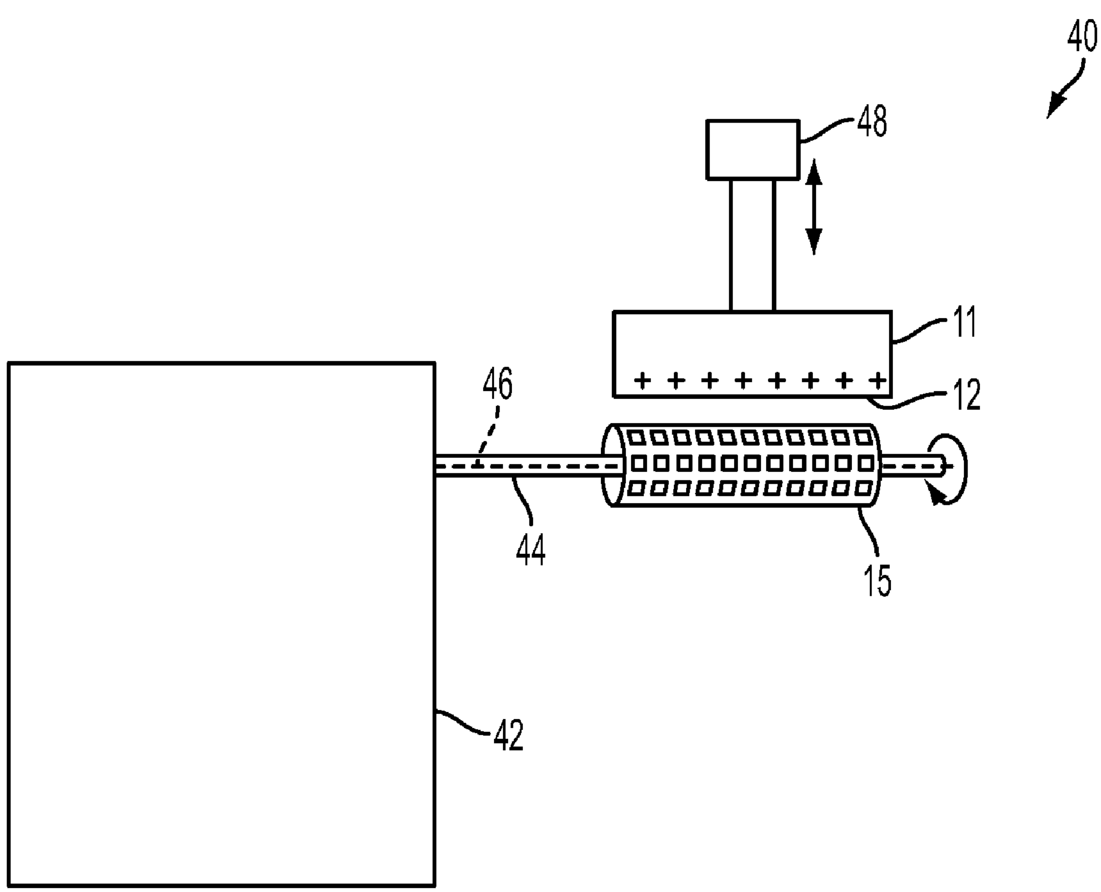
(57) **ABSTRACT**

A brush cleaning system comprising: a plate comprising at least one of silicon nitride (Si_xN_y) or silicon oxide (Si_aO_b), wherein the plate has a static charge on a surface thereof; and a machine configured to rotate a brush in contact with the static charged surface of the plate.

20 Claims, 3 Drawing Sheets



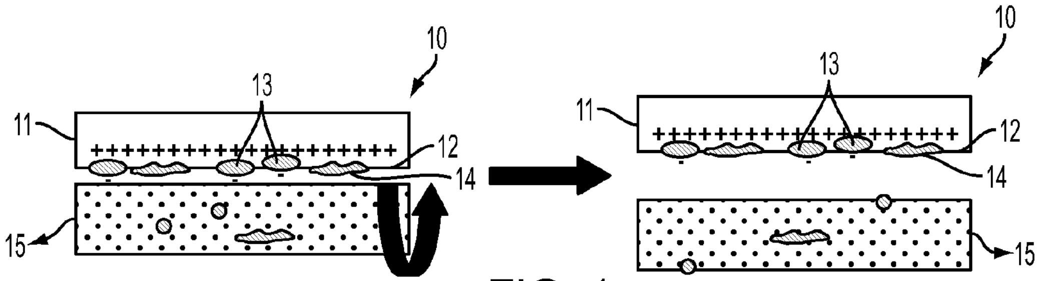


FIG. 1

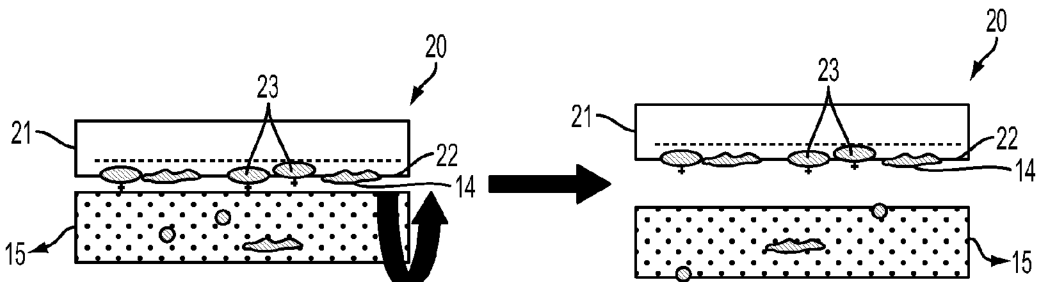


FIG. 2

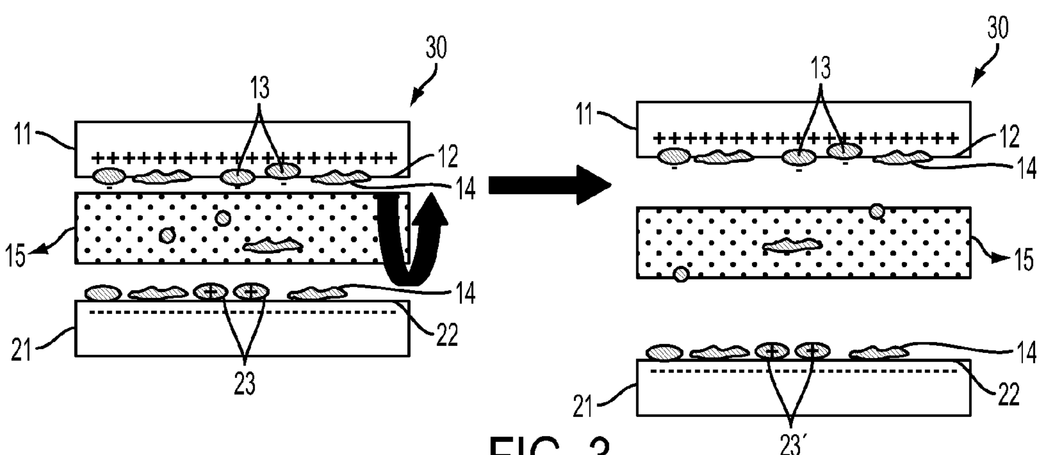


FIG. 3

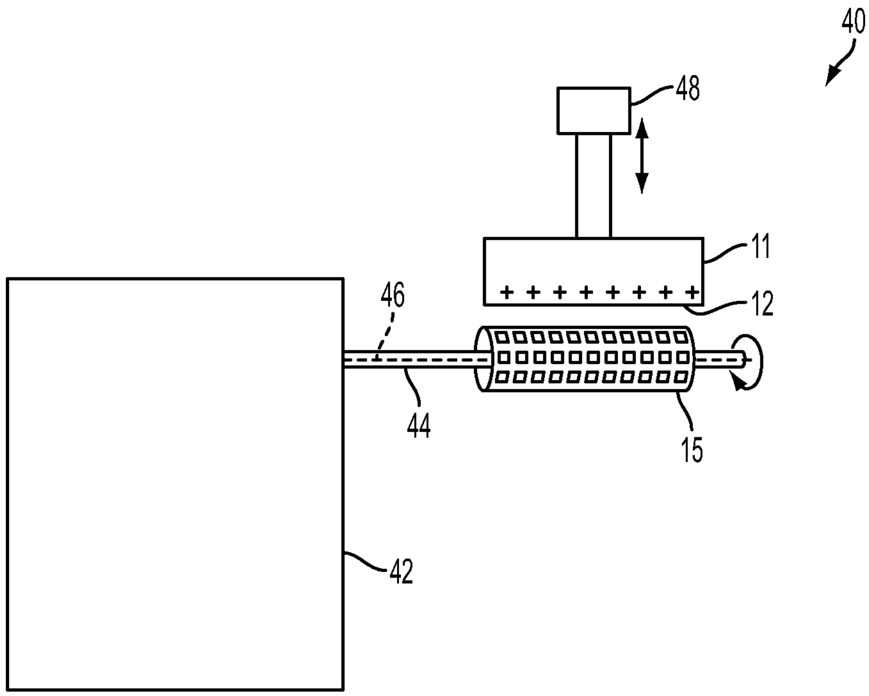


FIG. 4

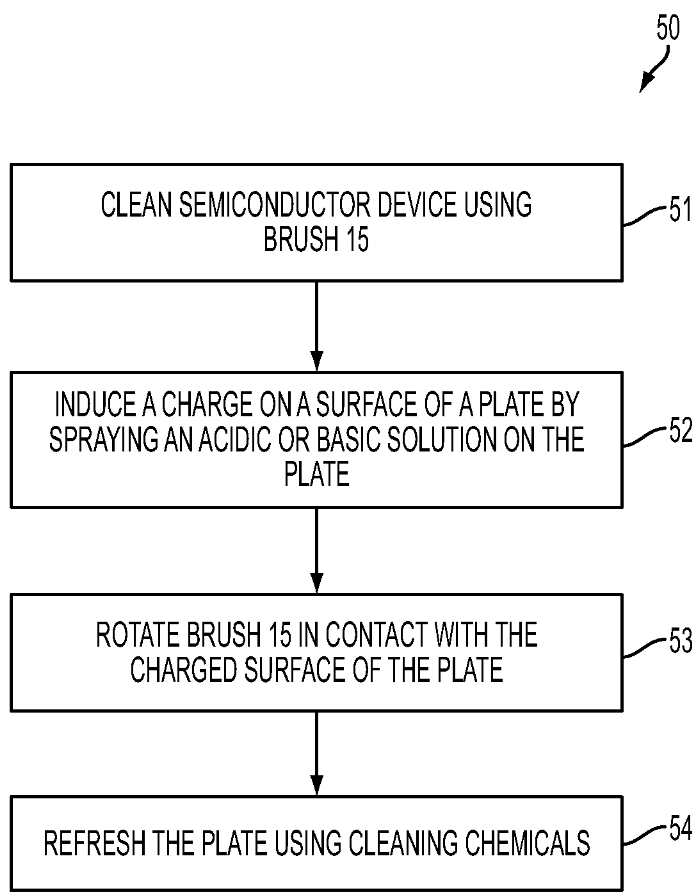

50
CLEAN SEMICONDUCTOR DEVICE USING BRUSH 15
51
INDUCE A CHARGE ON A SURFACE OF A PLATE BY SPRAYING AN ACIDIC OR BASIC SOLUTION ON THE PLATE
52
ROTATE BRUSH 15 IN CONTACT WITH THE CHARGED SURFACE OF THE PLATE
53
REFRESH THE PLATE USING CLEANING CHEMICALS
54

FIG. 5

BRUSH CLEANING SYSTEM

BACKGROUND

After chemical and mechanical polishing (CMP) of a semiconductor device, debris and residual solution are removed using a brush typical made of polyvinyl alcohol (PVA). As the brush cleans the semiconductor device, the brush itself becomes dirty and requires cleaning. If the brush is not thoroughly cleaned, debris and residue will be transferred onto subsequent semiconductor devices.

A conventional technique for cleaning a brush uses a quartz plate. A machine (brings the brush into contact with the quartz plate and rotates the brush. This cleaning method relies solely on mechanical force to remove debris and residual solution from the brush. It was found that conventional technique removes approximately 100 particles per minute of cleaning. Over time as the number of particles builds up on the brush, the effectiveness of the brush decreases and the brush must be replaced.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with standard practice in the industry various features may not be drawn to scale and are used for illustration purposes only. In fact, the dimensions of the various features in the drawings may be arbitrarily increase or reduced for clarity of discussion.

FIG. **1** is a side view of a diagram of an arrangement utilizing a positively charged plate to clean a brush according to some embodiments.

FIG. **2** is a side view of a diagram of an arrangement utilizing a negatively charged plate to clean a brush according to some embodiments.

FIG. **3** is a side view of a diagram of an arrangement utilizing multiple charged plates to clean a brush according to some embodiments.

FIG. **4** is a side view of a diagram of a cleaning system, according to one or more embodiments.

FIG. **5** is a flowchart for a method of cleaning a brush according to some embodiments.

DETAILED DESCRIPTION

It is understood the following disclosure provides many different embodiments, or examples, for implementing different features. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting.

The particles transferred to the brush during cleaning of a semiconductor device include charged abrasive particles and organic particles. The charged abrasive particles include metal particles removed during the CMP process. The organic particles include residue solution used in the CMP process. The conventional arrangement utilizes only mechanical force to scrape these particles off the brush, causing damage to the brush and leaving behind many particles. Better cleaning would increase the useful life of the brush thereby decreasing production costs.

In the embodiments of FIGS. **1-3**, the brush **15** has a cylindrical shape. In some embodiments, the brush **15** is an elongated cylinder. A cylindrical brush has protrusions extending perpendicular to the outer surface around the entire circumference. In some embodiments, the protrusions on the cylindrical brush are periodic. During the brush cleaning process, the cylindrical brush is rotated about its major axis, as shown in FIGS. **1-3**. In other embodiments, the brush has a disk shape. A disk shaped brush has protrusions extending perpendicular to a single cleaning surface or elongated protrusions spiraling from the center point of the disk. In some embodiments, the protrusions on the disk shaped brush are periodic. During the brush cleaning process, the disk shaped brush is rotated about an axis perpendicular to the cleaning surface. In further embodiments, the brush has a square shape, an x-shape or another shape.

FIG. **1** shows an arrangement **10** in which brush **15** is cleaned by plate **11**. A brush cleaning system **40** (FIG. **4**) brings the brush **15** into contact with plate **11** and rotates brush **15**. In an embodiment, the plate **11** comprises a silicon nitride (Si_xN_y, where x and y are integers). In other embodiments, the plate comprises a silicon oxide (Si_aO_b, where a and b are integers) or other materials. In some embodiments, x ranges from one to five. In some embodiments, y ranges from one to five. In some embodiments, a ranges from one to five. In some embodiments, b ranges from one to five. Plate **11** has a charge on surface **12**. In the embodiment of FIG. **1**, the surface charge is positive. In the embodiment of FIG. **1**, the positive charge on surface **12** is induced by spraying the plate **11** with an acidic solution (i.e. pH below 7). In some embodiments, the acidic solution comprises critic acid, phosphoric acid or another suitable acidic solution. The positively charged surface **12** employs static electricity to attract negatively charged particles **13** to the plate surface **12**. In addition, plate **11** uses mechanical force to remove neutral particles **14** and positively charged particles from brush **15**.

FIG. **2** shows an arrangement **20** in which brush **15** is cleaned by plate **21**. Brush cleaning system **40** (FIG. **4**) brings the brush **15** into contact with plate **21** and rotates brush **15**. In an embodiment, the plate **21** comprises a silicon nitride (Si_xN_y, where x and y are integers). In other embodiments, the plate comprises a silicon oxide (Si_aO_b, where a and b are integers) or other materials. Plate **21** has a charge on surface **22**. In the embodiment of FIG. **2**, the surface charge is negative. In the embodiment of FIG. **2**, the negative charge on surface **22** is induced by spraying the plate **21** with a basic solution (i.e. pH above 7). In some embodiments, the basic solution comprises tetramethylammonium hydroxide (TMAH) or another suitable basic solution. The negatively charged surface **22** employs static electricity to attract positively charged particles **23** to the plate surface **22**. In addition, plate **21** uses mechanical force to remove neutral particles **14** and negatively charged particles from brush **15**.

FIG. **3** shows an arrangement **30** in which brush **15** is cleaned by plates **11** and **21**. Brush cleaning system **40** (FIG. **4**) brings the brush **15** into contact with plates **11** and **21** and rotates brush **15**. In an embodiment, the plates **11** and **21** comprise a silicon nitride (Si_xN_y, where x and y are integers). In other embodiments, the plates comprise a silicon oxide (Si_aO_b, where a and b are integers) or other materials. In some embodiments, x ranges from one to five. In some embodiments, y ranges from one to five. In some embodiments, a ranges from one to five. In some embodiments, b ranges from one to five. Plate **11** can be the same material as plate **21** or a different material. In the embodiment of FIG. **3**, plate **11** has a positive charge on surface **12** to attract negatively charged particles **13**, and plate **21** has a negative charge on the surface **22** to attract positively charged particles **23**. The charge on surface **12** is induced by spraying plate **11** with an acidic solution. The charge on surface **22** is induced by spraying plate **21** with a basic solution. In the embodiment of FIG. **3**, brush **15** is cleaned simultaneously by plates **11** and **21**. In other embodiments, brush **15** is cleaned separately by plates **11** and **21**.

FIG. **4** shows brush cleaning system **40** including a base structure **42** and a shaft **44** connected to base structure **42**. Brush cleaning system **40** also includes brush **15** and plate **11**, as well as an actuator **48** configured to adjust a vertical position of plate **51**. Base structure **42** is configured to rotate shaft **44** about a longitudinal axis **46** thereof. In some embodiments, base structure **42** includes a mechanical motor, a piezoelectric rotary device, or other suitable rotation device.

Shaft **44** is configured to pass through a hollow center of brush **15**. In some embodiments, shaft **44** includes a threaded end which engages complimentary threads attached to brush **15**. Brush **15** is configured to attach to shaft **44**, such that brush **15** rotates as shaft **44** rotates.

Actuator **48** is configured to translate plate **51** to come into contact with brush **15** while brush **15** is rotating to remove charged particles **13** or **23** and neutral particles **14**. Following time duration ample to remove a sufficient number of charged particles **13** and neutral particles **14**, actuator **48** retracts plate **51** from brush **15**. In some embodiments, plate **51** has a positive charge on surface **52**. In some embodiments, plate **51** has a negative charge on surface **52**.

In some embodiments, cleaning system **40** includes a second actuator with a second plate configured to attach to the second actuator. In some embodiments, the second plate has the same surface charge as plate **51**. In some embodiments, the second plate has a different surface charge than plate **51**. In some embodiments, cleaning system **40** is configured in such a manner that the second plate and plate **51** contact brush **15** simultaneously. In some embodiments, cleaning system **40** is configured in such a manner that the second plate and plate **51** contact brush **15** sequentially.

FIG. **5** shows a method **50** of cleaning a brush **15** using a plate with a charged surface. Method **50** begins with step **51** in which the brush **15** cleans the surface of a semiconductor device. During the cleaning process abrasive particles and residue solution transfers from the semiconductor device to brush **15**. After cleaning a semiconductor device, brush **15** must itself be cleaned to avoid transferring particles and residue solution onto subsequent semiconductor devices.

In step **52**, a charge is induced on a surface of the plate by spraying the plate with a solution. The charged surface uses static electricity to attract oppositely charged particles from brush **15**. The oppositely charged particles are thus removed with minimal mechanical force.

In step **53**, brush **15** is brought into contact with the charged surface of the plate and brush **15** is rotated. The cleaning process in step **53** utilizes both static charge attraction as well as mechanical force to remove particles and residue solution from the brush. It was found by utilizing a cleaning plate with a charged surface the cleaning rate is between about 4,000 and about 5,000 particles a minute. In contrast, conventional cleaning using only mechanical force yields a cleaning rate of only about 100 particles per minute. By using a plate with a charged surface, it was found a brush can effectively clean between about 2,000 to about 2,500 wafers before being replaced. Using the conventional brush cleaning method, the brush needs to be replaced after cleaning about 1,000 wafers.

In step **54**, the plate used to clean brush **15** is refreshed by cleaning chemicals. In an embodiment using a silicon nitride plate, the cleaning chemicals comprise phosphoric acid or another suitable cleaning solution. In an embodiment using a silicon oxide plate, the cleaning chemicals comprise hydrofluoric acid or another suitable cleaning solution.

One aspect of the description relates to a cleaning system for a brush using a plate having a silicon nitride or a silicon oxide and having a charge induced on a surface thereof and a machine to rotate the brush against the charged surface of the plate. Another aspect relates to a method of cleaning a brush by inducing a charge on the surface of a plate by spraying the plate with a solution, wherein the plate comprises a silicon nitride or a silicon oxide and the brush is rotated against the surface of the plate. A further aspect concerns a cleaning system for a brush having a plate comprising a silicon nitride having a positive charge on the surface thereof and a machine to rotate the brush against the positively charged surface of the silicon nitride plate.

What is claimed is:

1. A brush cleaning system comprising:

a first plate comprising at least one of silicon nitride (Si_xN_y) or silicon oxide (Si_aO_b), wherein the first plate has a static charge on a surface thereof wherein a, b, x and y are integers; and

a machine configured to rotate a brush in contact with the static charged surface of the first plate.

2. The brush cleaning system of claim **1**, wherein the first plate comprises Si_xN_y, where x and y are integers which range from one to five.

3. The brush cleaning system of claim **1**, wherein the first plate comprises Si_aO_b, where a and b are integers which range from one to five.

4. The brush cleaning system of claim **1**, wherein the static charge is a positive charge.

5. The brush cleaning system of claim **1**, wherein the static charge is a negative charge.

6. The brush cleaning system of claim **1**, further comprising:

a second plate comprising silicon nitride (Si_xN_y),wherein the second plate has a static charge on a surface thereof,

the static charge on the surface of the second plate is different than the static charge on the surface of the first plate, and

the machine configured to rotate the brush in contact with the static charged surface of the second plate.

7. The brush cleaning system of claim **6**, wherein the brush is in contact with the first plate and the second plate simultaneously.

8. The brush cleaning system of claim **6**, wherein the brush is in contact with only one of the first plate or the second plate at a time.

9. A brush cleaning system comprising:

a first plate comprising Si_xN_y, where x and y are integers, having a positive static charge on a surface thereof; and

a machine configured to rotate a brush in contact with the positive static charge surface of the first plate.

10. The brush cleaning system of claim **9**, further comprising:

a second plate comprising silicon oxide having a negative static charge on a surface thereof, and

the machine configured to rotate the brush in contact with the negative static charge surface of the second plate, wherein the brush contacts the first plate and the second plate simultaneously.

11. The brush cleaning system of claim **9**, further comprising:

a second plate comprising silicon oxide having a negative static charge on a surface thereof, and

the machine configured to rotate the brush in contact with the negative static charge surface of the second plate, wherein the brush contacts only one of the first plate and the second plate at a time.

12. A brush cleaning system comprising:

a first plate comprising at least one of silicon nitride (Si_xN_y) or silicon oxide (Si_aO_b), wherein a, b, x and y are integers and the first plate has a first static charge on a surface thereof;

a second plate comprising at least one of silicon nitride or silicon oxide, wherein the second plate has a second static charge on a surface thereof; and

a machine configured to rotate a brush in contact with at least one of the static charged surface of the first plate or the static charged surface of the second plate.

13. The brush cleaning system of claim **12**, wherein the first static charge is opposite the second static charge.

14. The brush cleaning system of claim **12**, wherein at least one of the static charged surface of the first plate or the static charged surface of the second plate has a basic solution thereon.

15. The brush cleaning system of claim **14**, wherein the basic solution comprises tetramethylammonium hydroxide (TMAH).

16. The brush cleaning system of claim **12**, wherein at least one of the static charged surface of the first plate or the static charged surface of the second plate has an acidic solution thereon.

17. The brush cleaning system of claim **16**, wherein the acidic solution comprises citric acid or phosphoric acid.

18. The brush cleaning system of claim **12**, wherein the machine is configured to rotate the brush in contact with both the static charged surface of the first plate and the static charged surface of the second plate.

19. The brush cleaning system of claim **12**, wherein the static charged surface of the first plate has a same charge as the static charged surface of the second plate.

20. The brush cleaning system of claim **12**, wherein the static charged surface of the first plate is positively charged.

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